WEEKLY REPORT – SINDHUJA CHADUVULA

SCENARIO 1 – Analyzing Diverse Driving Behaviors in Traffic Simulation

We continued our traffic simulation study using SUMO, focusing on analyzing the behavior of various vehicle types under different traffic conditions. The simulation incorporated seven distinct vehicle types, including default, aggressive, speeder, distracted, inexperienced, tailgater and passive, each with unique driving characteristics.

Seven Distinct Driving Behaviors
Passive Drivers : Embodying a safety-first approach, passive drivers consistently adhere to lower speed limits and prioritize keeping a substantial gap between themselves and the car ahead. Their cautious nature stems from a blend of moderate acceleration and deceleration patterns coupled with a deliberate reaction time, ensuring they avoid hasty decisions on the road.

Aggressive Drivers: Aggressive drivers exhibit a high-risk driving style with a very high maximum speed and rapid acceleration and deceleration rates, indicating a preference for quick maneuvers. Their minimum following gap is moderate, but with an extremely low time headway (tau), they tend to follow the vehicle in front very closely, potentially leading to tailgating. The use of specific lane change and car following models (LC2013 and EIDM) indicates that their behavior is influenced by sophisticated models aiming to replicate aggressive driving tendencies accurately.

Tailgaters: Tailgaters are characterized by their tendency to follow the vehicle in front extremely closely, as indicated by their low minimum gap and time headway. They have moderate acceleration and deceleration rates and a higher emergency deceleration rate, suggesting a potential for abrupt stops. The impatience parameter is set to its maximum, indicating a lack of willingness to wait, which is typical of tailgating behavior.

Speeders: Speeders are drivers who prefer to drive at high speeds, as indicated by their very high maximum speed. They have rapid acceleration and deceleration rates, showcasing a tendency for swift speed changes. Despite their high speeds, they maintain a moderate minimum gap and have a relatively high time headway, indicating a willingness to keep some distance from the vehicle in front, which is a bit surprising for a typical speeder. The impatience parameter is set to its maximum, suggesting a low tolerance for being slowed down by other vehicles. These driver types add a level of complexity and realism to your traffic simulation, reflecting the diversity of driving behaviors found on real roads.

Default Drivers: Default drivers represent the average driver on the road. They have a moderate maximum speed and acceleration, with a slightly higher deceleration rate indicating a tendency to brake harder than they accelerate. They maintain a small minimum gap to the vehicle in front, and their time headway (tau) is set to 1 second, which is a common rule of thumb for safe following distances. The driver imperfection (sigma) is set to

0.5, indicating a moderate level of variability in their driving behavior, making them neither too robotic nor too unpredictable.

Inexperienced Drivers: Inexperienced drivers are characterized by their cautious driving behavior. They have the same maximum speed as default drivers but exhibit lower acceleration and deceleration rates, indicating a more gentle approach to speed changes. They maintain a larger minimum gap to the vehicle in front and have a longer time headway (tau), indicating a preference for maintaining a safer following distance. This behavior is representative of drivers who are less confident or less skilled, perhaps due to a lack of experience behind the wheel.

Distracted Drivers: Distracted drivers have a driving profile similar to default drivers in terms of speed and acceleration, but they exhibit lower deceleration rates, indicating a potentially delayed reaction to the need to slow down or stop. Their minimum gap and time headway are set to moderate values, but the presence of sigmaerror (which could represent random errors in acceleration) suggests that these drivers may not always respond appropriately to traffic conditions, possibly due to distractions inside or outside the vehicle. This type of behavior can be representative of drivers who are texting, talking on the phone, or otherwise not fully paying attention to the road. These driver types help in creating a diverse and realistic simulation environment, reflecting the varying behaviors observed on real roads.

Change in parameters based on vehicle types

Acceleration

The “Aggressive” and “Speeders” drivers have the highest acceleration rates. “Passive” and “Inexperienced” drivers have lowest acceleration rates. Other vehicles have moderate acceleration rate.

Deceleration

“Aggressive” and “Speeders” drivers have the highest deceleration rate, “Passive” and “Inexperienced” drivers have lower deceleration rates, the rest fall in between.

Emergency Deceleration

“Aggressive” and “Tailgaters” have the highest emergency deceleration rate. “Passive” drivers have the lowest emergency decelaration.

Tau

The parameter tau in traffic simulation with SUMO represents the vehicle's desired time headway, which is the time gap that a driver wishes to maintain with the vehicle in front.

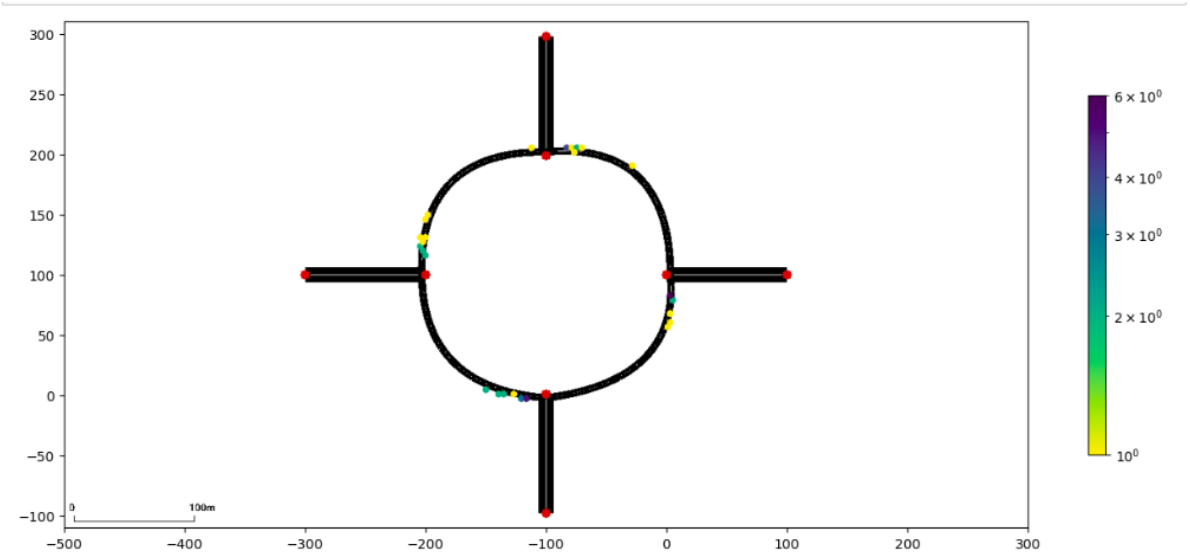
Short time headway - "Aggressive" and "Tailgater" drivers have very short desired time headways at 0.1 and 0.25 seconds, respectively. This implies that they prefer to drive very close to the vehicle in front of them, leading to a more compact traffic flow but also a higher risk of collision.

Moderate time headway – "Default" drivers have a moderate desired time headway at 1.0 seconds, representing a balanced driving style.

Long time headway – “Speeder," "Passive," "Distracted," and "Inexperienced" drivers have longer desired time headways, ranging from 1.75 to 2.5 seconds. These longer time

headways imply a more cautious driving style, with drivers preferring to maintain a larger gap with the vehicle in front of them, leading to a more spread-out traffic flow.

Analysis of Collisions When Exiting the Roundabout:



Deceleration and Following Distance:

- Vehicles generally reduce their speed when exiting a roundabout to navigate the turn safely and to merge onto the exit road.
- Tailgater vehicles, characterized by their very low minimum gap (1m) and time headway (0.25s), tend to follow the leading vehicle extremely closely. This following behavior leaves an insufficient safety buffer for them to react and decelerate safely when the leading vehicle slows down to exit the roundabout.
- Aggressive vehicles, despite having a slightly higher minimum gap (4m), have a very low time headway (0.1s), indicating a tendency to follow closely at higher speeds. Their high maximum speed (35m/s) and acceleration (5m/s²) can exacerbate the situation as they approach the exit at higher speeds, requiring more distance and time to decelerate safely.

Aggressive Driving Behavior and Exit Path Misjudgment:

- Aggressive vehicles have parameters indicating a propensity for risk-taking and assertive driving. This can lead to misjudgment of exit paths and inadequate spacing with other vehicles, increasing the likelihood of collisions at the exits.
- Tailgaters, with their low tau and minimum gap, may also engage in risky maneuvers to follow closely, which can lead to accidents, especially if they misjudge the speed and distance required to exit safely.

Interaction with Other Vehicle Types:

- The roundabout environment consists of various vehicle types with different driving behaviors. The aggressive and tailgater vehicles' tendencies to follow closely and

drive at higher speeds can result in unsafe interactions, especially with vehicles that have larger minimum gaps and longer headways, leading to a higher risk of rear-end collisions at exits.

Potential for Chain-Reaction Accidents:

- The close-following behavior of tailgaters and aggressive vehicles not only puts them at risk but also the vehicles around them. A sudden deceleration by a vehicle exiting the roundabout can lead to a chain-reaction accident, where the tailgater or aggressive vehicle may collide with the leading vehicle, potentially causing subsequent collisions with following vehicles.